History of Controlled Environment Horticulture: Ancient Origins

Jules Janick

Department of Horticulture and Landscape Architecture, Purdue University, West Lafayette, IN 47907

Harry Paris

Department of Vegetable Crops & Plant Genetics, Agricultural Research Organization, Newe Ya'ar Research Center, P.O. Box 1021, Ramat Yishay 30-095, Israel

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Abstract. In the first century CE, two Roman agricultural writers, Lucius Junius Moderatus Columella and Gaius Plinius Secundus (Pliny the Elder), referred to proto-greenhouses (*specularia*) constructed for the Emperor Tiberius (42 BCE–37 CE) presumably adjacent to his palace, the Villa Jovis on the Isle of Capri. Pliny stated in *Historia Naturalis* (Book 19, 23:64) that the *specularia* consisted of beds mounted on wheels that were moved into the sun, and on wintry days withdrawn under the cover of frames glazed with transparent stone (*lapis specularis*) to provide fruits of *cucumis*. According to Pliny, this was “a delicacy for which the Emperor Tiberius, had a remarkable partiality; in fact there was never a day on which he was not supplied it.” The *cucumis* fruits described by Columella and Pliny, long mistranslated as cucumbers, *Cucumis sativus*, were in fact long-fruited melons, *Cucumis melo* subsp. *melo* Flexuosus Group. They are known today as vegetable melons, snake melons, and *faqqous*, and were highly esteemed in Rome and ancient Israel.

The origins of controlled environment horticulture are to be found in the Roman proto-greenhouse constructed to grow *cucumis* for Rome's second emperor, Tiberius Caesar Augustus (42 BCE–37 CE) (Fig. 1A). These structures were probably located adjacent to his palace, the Villa Jovis, on the Isle of Capri (Fig. 1B). Tiberius, emperor from 14 to 37 CE, reigned during the crucifixion of Jesus, as mentioned in the New Testament (Luke 3:1). The verse “Render therefore unto Caesar the things which are Caesar's and unto God the things that are God's” (Matthew 22:17), refers to Tiberius.

Ancient Roman Sources

Two surviving first-century Roman texts, *De Re Rustica* (On Agriculture) written by Lucius Junius Moderatus Columella, 4 BCE to 70 CE (Fig. 2A), and *Historia Naturalis* (Natural History) written by Gaius Plinius Secundus, 23 to 79 CE, known as Pliny the Elder (Fig. 2B), provide contemporary details

of environmental control for *cucumis*, of which Emperor Tiberius was exceedingly fond.

De Re Rustica. “Anyone who wishes to have the fruits of cucumber [*cucumis*] ripen earlier than usual should, when midwinter is past, produce well-manured soil enclosed in baskets and give it a moderate amount of water; then, when the seeds have come up, he should place the baskets in the open air on

warm and sunny days near a building, so that they may be protected from any blasts of wind; but if it is cold and stormy, he should bring them back under cover and continue to do so until the spring equinox is over. He should then sink the whole baskets into the ground. He will then have early fruits. It is also possible, if it be worth the trouble, for wheels to be put under larger vessels, so that they may be brought out and then taken indoors again with less labour. In any case the vessels ought to be covered with slabs of transparent stones [*specularibus*] so that even in cold weather, when the days are clear, they can safely be brought out into the sun. By this method Tiberius Caesar was supplied with *cucumis* during almost the whole year.” *De Re Rustica* XI. III. 52–53 (Forster and Heffner, 1955).

HISTORIA NATURALIS. “Belonging to the class of cartilaginous plants and growing on the surface of the ground is the cucumber [*cucumis*] for which the emperor Tiberius had a remarkable partiality: in fact, there was never a day which he was not supplied with it, as his kitchen gardeners had cucumber [*cucumis*] beds mounted on wheels which they moved out into the sun and then on wintry days withdrew under the cover of frames glazed with transparent stone.” *Historia Naturalis* XIX. XXIII. 64 (Rackham, 1950).

Environment control. Columella recommends two methods for early production of *cucumis*: (1) placing containers of seedlings next to buildings that provide heat, or (2) setting plants under frames covered with *lapis specularia* (transparent stone). Both of Columella's methods represent environmental control. Pliny repeats the story of the *specularia* and associates it with the predilection of Tiberius for *cucumis*. The use of frames covered with transparent stone is

Fig. 1. (A) Bust of Tiberius Caesar (Paris and Janick, 2008). (B) Ruins of Villa Jovis on the Isle of Capri.

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J.J. is the corresponding author. E-mail: knemali@purdue.edu.

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Fig. 2. (A) Statue of Lucius Columella, Cadiz, Spain. (B) Gaius Plinius Secundus (Pliny the Elder).

Fig. 3. A reconstruction of the specularia, Roman proto-greenhouse covered with transparent stone (*lapis specularia*) a translucent gypsum (selenite) that forms crystal sheets similar to mica.

Fig. 4. Partial view of snake melon 'Striped Armenian' (left) and of Bet Alfa-type cucumber 'Shimshon' (right). Notice the presence of hairs on the snake melon and their absence on the cucumber.

a proto-greenhouse. No contemporary illustrations exist, but a suggested reconstruction of the Roman *specularia* is presented in Fig. 3.

Transparent stone (*lapis specularia*) was a variety of gypsum mined in the province of Cuenca, Spain, known as selenite,

which forms transparent thin sheets, similar to mica (Serrano-Viñuelas, 2016). It was used by the Romans for skylights and window panes. Glass was known to the Romans, but there was no method to make it into sheets. The selenite sheets represent the earliest greenhouse cover. The material

was later replaced by glass in the Renaissance, transparent paper in 15th century Asia, and polyethylene films in the 20th century. In the 21st century, artificial lighting has replaced sunlight, and transparent covers are no longer required in modern vertical structures.

Taxonomic Identity of the Roman Latin *Cucumis*

Most modern translations of Columella and Pliny assume *cucumis* refers to cucumber, *Cucumis sativus* L., and this mistranslation is almost universal, even in contemporary literature. However, cucumber is clearly a mistranslation based on the descriptions of *cucumis* in Columella and Pliny (Dalby, 2003; Janick et al., 2007). In Book 10 of *De Re Rustica*, Columella described the *cucumis* as hairy (*hirtus*) and snake-like. Likewise, Pliny, in Book 19 of *Historia Naturalis*, wrote that the very young fruits of the *cucumis* were covered with white down (*lanugine*). Young melon fruits are typically pubescent, but cucumber fruits are not (Fig. 4). Also, cucumber fruits typically sport tubercles, which are not mentioned. The *cucumis* described by Columella and Pliny was likely the same as the *sikyos* of the ancient Greeks and the *qishu'im* of ancient Israel (Janick et al., 2007; Paris, 2015; Paris and Janick, 2010–2011), taxonomically *Cucumis melo* subsp. *melo* Flexuosus Group (L.) Naudin, the snake melon. Snake melons have been commonly grown in Mediterranean lands since ancient times, through the medieval period and to the present (Paris, 2011). Known as *faqqous* in that region, snake melons are presently sold as "Armenian cucumbers" in the United States. Various images of snake melons have survived from antiquity (Fig. 5; Janick et al., 2007; Avital and Paris, 2014). Pliny distinguishes between *cucumis* (pliable skin) and *cucurbita* (rind), the latter being another cucurbit, *Lagenaria siceraria* (Mol.) Standl., the bottle gourd. The first image of cucumber, *Cucumis sativus*, dates to 1335 (Fig. 6), indicative of its arrival in Europe from Asia after the fall of the Roman Empire, in the medieval period, probably by both overland and sea routes (Paris et al., 2012). The better adaptation of *C. sativus* to the cool climate of Europe is what probably led to its gradual replacing of elongate-fruited *C. melo* on that continent (Paris et al., 2011).

Conclusions

The origins of controlled-environment horticulture is the Roman *specularia*, which were wooden frames covered with transparent stone, a form of gypsum (selenite), known to the Romans as *lapis specularia* or transparent stone. The *specularia* was used for out-of-season culture of long-fruited melons, *C. melo* Flexuosus Group.

Fig. 5. Ancient images of long-fruited cucurbits identified as *Cucumis melo* Flexuosus Group: (A) Egyptian Old Kingdom (1550–1300 BCE). (B) Four snake melons, one in a glass jar presumably used for pickling in the Roman town of Ercolao (Herculanum) destroyed by Mount Vesuvius in 79 CE. (C) Second century Tunisian mosaic. (D) Third century Greek tomb painting. (E) Fourth century, Merida Spain (Janick et al., 2007).

Fig. 6. Cucumber (*Cucumis sativus*) from the manuscript *Manfred de Monte Imperiali*, Pisa, Italy, ca. 1335 (Paris et al., 2011).

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